Preliminary Investigation of the Lakes of Kosciusko County

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Funded by:
Kosciusko Lake Preservation and Development Council, and the Indiana Department of Natural Resources' Lake Enhancement Program

March 1989

Property of
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Acknowledgments

A project of this size cannot be effectively completed without the assistance of many individuals. John Weyler of the Kosciusko County Lake Preservation and Development Council, Sam St. Clair, District Conservationist, Jon Cupp, County Sanitarian and Dick Kemper, County Surveyor all contributed valuable information.

Field and laboratory work was provided by Kevin Green, Bill Hartsuff, Mike Orcutt, and John Berger.

The Lake Enhancement Team of Gary Doxtater and Brenda Knox were always encouraging as we worked our way through these initial lake enhancement studies in the State of Indiana.

Executive Summary

Accelerated eutrophication is of concern in most of the twenty eight lakes studied in this preliminary investigation in Kosciusko County. Many lakes in the county are grouped together in chains which link many of the water quality characteristics of each lake chain.

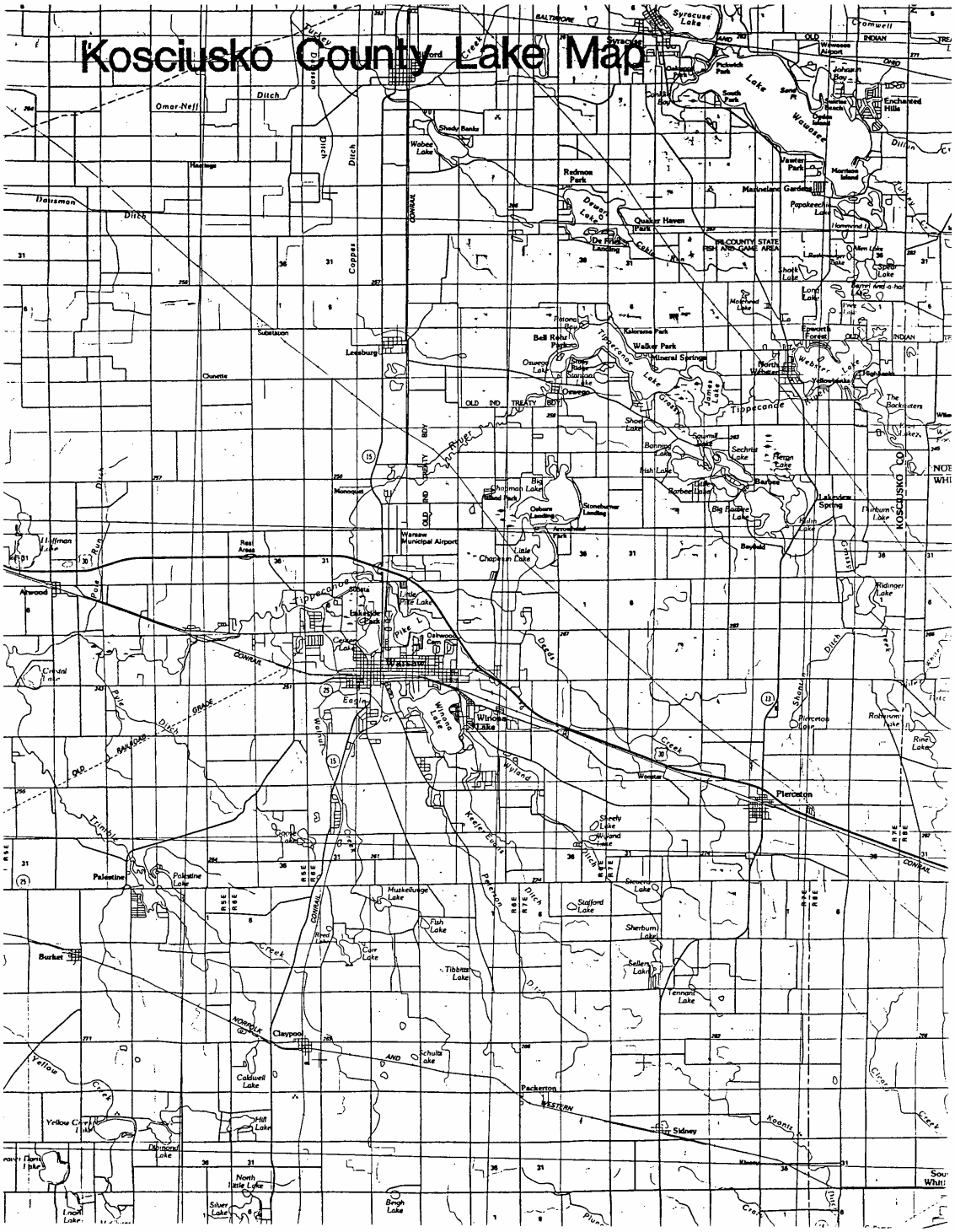
The three main watershed activities that impact the lakes studied are as follows:

1. Agricultural - The amount of highly erodible land in each watershed indicates the potential for high sediment and nutrient inputs from these areas, if best management practices are not being utilized. Also, various types of confined feeding operations are contributing nutrients when not properly designed or managed.
2. Development activity - Both residential and commercial activity is contributing sediments and nutrients when no or incomplete erosion control methods are being used in design and construction. The use of non-agricultural erosion control practices needs to be thoroughly implemented by many governmental agencies and individual developers. Alternative methods of sewage treatment for septic systems in areas of highly porous soils and/or high ground water need to be implemented.
3. Sewage Treatment Plants - Several public and semi-public treatment plants need to be upgraded. This will require both increased financial support and improved monitoring of these facilities.

This study identified four priority watersheds that have critical and solvable problems.

1. Wyland Ditch Watershed on Winona Lake - The large sandbar at the mouth of the ditch on the south edge of the public beach should be removed. At the same time several practices in the watershed could be implemented to reduce the sediment and nutrient inflow into Winona Lake. DESIGN
2. Stonebruner-Putney Ditch Watershed on Little Barbee - The sandbar in the lake and the sediment in the filled channel should be removed. Erosion control practices and possible wetland construction would prove very beneficial to Little Barbee. This improvement would also impact several other lakes in the Barbee and Tippecanoe chains. DESIGN
3. Pike and Little Pike Lakes and the Deeds Creek Watershed - There are several factors in this large watershed such as Pierceton's S.T.P., animal waste from feedlots, and development activity on the east side of Warsaw that all contribute to the water quality problems of Pike and Little Pike Lakes. FEAS.
4. Ridinger Lake and its watershed of Shanton and Elder Ditches - Ridinger Lake had the highest phosphate level of the Barbee chain. This lakes buffers the impact of watershed activity in both Whitley and Kosciusko Counties from the entire Barbee Chain and Tippecanoe Lake. Therefore, its improvement would benefit many lakes. FEAS.

Kosciusko County Lake Map



Objectives of Study

The lakes of Kosciusko County are located in two separate watershed basins. The northeastern portion of the county is in the St. Joseph River Basin draining into Lake Michigan. Only three lakes, Dewart, Syracuse, and Wawasee, included in this study are in this basin. The remaining twenty five lakes of this study are in the Tippecanoe River Basin. One unique feature of many of these lakes are that several lakes are grouped together in chains. The Tippecanoe Lake chain consisting of twelve lakes in two main branches., Both the Webster Lake chain and the Barbee chain contribute about equal amounts of water inflow into Tippecanoe Lake.

The Yellow Creek chain of four lakes is found in the southwestern portion of the county. The Deeds Creek watershed containing Big Chapman, Little Chapman, Little Pike, and Pike lakes is located east of Warsaw. The small lakes of Sellers and Serburn are at the headwaters of the Wyland Ditch which flows into Winona Lake. The outflow of Wawasee enters Syracuse lake. Caldwell Lake is in the Slone-Adams watershed which flows into Palestine Lake. The single lake watersheds of Carr, Silver, Dewart, and Hoffman were also studied.

Various land use activities were analyzed for their impacts on the water quality the Kosciusko County lakes. The types of activity looked at most closely were agriculture, residential and commercial construction, sewage treatment plants, and lake residential development. The changes in lake water quality over the past several years was compared using both phosphate and secchi disk data.

Agriculture

Of the 355,200 acres in Kosciusko County approximately 80 percent is in farms. Cropland dominates the agricultural use with 75% and pasture and woodlands contributing equal shares of the remaining 25%. In an effort to identify problem areas. The amount of highly erodible land was determined from the soils maps from the Kosciusko County soil survey. This information is on Table 1 and the percent H.E.L. is compared on Figure 1. The highly erodible land varies from a high of 70% in the Slone-Adams watershed of Palestine Lake to a low of 2.3% in the Hoffman Lake watershed. The higher values indicate areas of concern, but if the farm is using current best management practices to prevent soil erosion these need not contribute significant sediments and nutrients to the lakes. Because of the extremely low rainfall during the summer of 1988, erosion problems were not detected in the water quality of the inflows. The longer term data obtained from previous monitoring of the Barbee Lake Chain, shown on Figure 2, is an indicator of the nutrient input that effect the lakes. Other studies such as the Black Creek project in Allen County and the Skinner Lake project in Noble County demonstrate that highly erodible

soils can be farmed with the proper land treatment measures to produce the double benefit of maintaining the productivity of the soil and preventing sediment and nutrient problems down stream.

The trend to produce animals in confined feedlots has the potential for significant bacterial and nutrient input into the lakes if these operation are not properly designed and managed. The Indiana Department of Environmental Management lists 172 animal operations large enough to require a permit in Kosciusko County. Only 70 of these animal operations have been inspected to determine if the facilities are adequate. It is unknown how many of these farmers are adequately managing their operation to prevent pollution into the ditches and ultimately the lakes. From some samples taken in the Deeds Creek, Silver Lake, and Yellow Creek Lake Watersheds it is obvious that some animal operations are contributing to poor water quality.

Through better monitoring by the IDEM or local health department, some farmers should be required to improve their management. Also the Kosciusko County Soil and Water Conservation District needs to provide additional assistance to upgrading certain critical operations. The establishment of buffer strips on some ditches next to these feedlots would reduce the impact of the runoff on water quality.

Drainage is a factor related to the water quality in the inflows. Stream channels often become sediment reservoirs for eroded upland soil. Also unstable banks will contribute to in stream erosion. Therefore the creation of sediments basins or new wetlands can provide protection for the water resources of the county. If these techniques can be used to improve water quality, it should be obvious that certain natural wetlands should not be drained or filled for the same reason. The design of ditches with the maintenance of good water quality as part of the design criteria will have the double benefit of lower maintenance costs and better water quality.

Non-Agricultural Erosion

Many construction activities can contribute large amounts of sediments to off site locations such as the ditches and lakes. Both commercial and residential development need to practice erosion control methods during construction. The development should be designed to reduce off site runoff problems.

The Stonehenge golf course and residential development is a good example of how a development without the proper erosion control design can create problems both for themselves and property downstream. The rapidly increasing sandbar at the mouth of the Wyland Ditch in Winona Lake is partially the result of poor design at Stonehenge.

The development east of Warsaw in the Pike Lake watershed has created sediments problems for Pike. Erosion during commercial development and infringement on wetlands that have

filtered the sediments and nutrients, and have also buffered the surge of storm water runoff into Pike Lake needs to be carefully monitored.

Local plan commissions need to include design criteria in their ordinances that minimize erosion at the site of new development. The non-agricultural technicians employed by the Indiana Department of Natural Resources with T by 2000 funds need precise training on erosion control methods that should be used in the development of residential subdivisions, industrial parks and other commercial developments so that they can better assist planners and developers alike. It is much cheaper to prevent these types of erosion problems from happening than it is to try to correct the problems once the buildings, parking lots, and roads are in place.

Sewage Treatment Plants

There are several public and semi-public sewage treatment plants that drain their effluent into ditches that flow into some the Kosciusko lakes. The municipal sewage of North Webster, Pierceton, and Silver Lake all ultimately enter lakes down stream. Therefore it is imperative that these towns manage their sewage in the most efficient way.

North Webster is now treating the sewage from Epworth Forest (North Shore Public Utility). In the 1970's this was not the case. The effluent from Epworth Forest then entered Webster Lake. Since the connection to North Webster's S.T.P., it is interesting to note that on Figure 5 the clarity of water in Webster Lake has increased the same amount that the clarity of James Lake has declined over the past ten years. The effluent from Epworth Forest, under normal conditions, now flows through the North Webster's S.T.P. and into James Lake by the way of the Tippecanoe River. All five of the lift stations of North Shore Public Utilities' overflows discharge into Webster Lake. This can still cause pollution problems for Webster Lake during storm events or equipment failure.

Pierceton's sewage treatment plant has been in non-compliance with its NPDES permit for so long that the IDEM has brought legal action against the town for violations of their permit. These excess nutrients that Pierceton is dumping into Deeds Creek end up in Pike Lake.

The town of Silver Lake has very high phosphate levels flowing from their drains into Silver Lake. Enforcement proceedings in progress against the town indicates that they must be in compliance by December of 1989. Silver Lake received funding from the State of Indiana in the fall of 1988 to improve their sewage treatment.

The Yogi Bear Campground on Ridinger Lake has its own treatment plant. The plant has no phosphate limits in its NPDES permit, but does not appear to be adding significant amounts phosphate to Grassy Creek. The elevated levels of phosphate in Grassy Creek, Figure 2, are coming from internal

loading in Ridinger Lake, Figure 6, or from the Elder Ditch (Grassy Creek) in Whitley County.

Kosciusko County has several mobile home parks that operate semi-public sewage treatment plants. The majority of these plants discharge into ditches that flow into the Tippecanoe River rather than into a county lake. This is not the case for Green Acres Mobile Home Park which discharges into Deeds Creek. Lite Breeze Mobile Home Park wants to connect to the Pierceton S.T.P., but this would not correct the pollution problem in Deeds Creek until Pierceton upgrades their plant. Most of these plants were not in compliance either due to B.O.D. or suspended solids above their permit or not analyzing their effluent for their monthly reports to the Indiana Department of Environmental Management. One mobile home park, Westhaven Estates, has not filed a complete report for seven years. Since these plants are permitted and monitored by the IDEM, it is time that both the managers of the mobile park's sewage treatment plants and the IDEM improve their performance.

Lake Residential

The development around most of the counties' lakes is extensive. Many times seasonal cottages were placed on small lots with soils that do a poor job of supporting a properly functioning leach field. Many of these seasonal cottages have been converted to year around homes. This increased use places additional stress on many marginal septic systems. A study on the Alternative Waste Systems for Rural Lake Projects in Steuben County reached the following conclusions. Most of the nitrates and phosphates from septic tank effluents near lakes will reach the lake. This is particularly true for systems in porous soil and in locations with high ground water. Since the lake residential conditions in Kosciusko are almost identical to Steuben County, these critical area of high soil porosity and a high ground water table should consider alternative septic systems such as off site cluster systems and mounds.

Lawn fertilization should be limited and done with care. The leaves and grass clipping should not be raked or dumped into the lake. These factors all contribute nutrients to the lake. It does not make any difference to the algae or weeds where they get the nutrients to grow.

Watershed Acreage and Percent Highly Erodible Land

Lake	Ditch	Drainage Acreage	H.E.L.	% HEL
Palestine				
	Williamson	6300	1253	19.9
	Slone-Adams	3910	2738	70.0
	Cauffman	7120	1714	24.1
	Magee	1700	398	23.4
	Total	19030	6103	32.1
Winona				
	Peterson	7026	2305	32.8
	Keefer-Evans	2919	678	23.2
	Wyland	8785	3479	39.6
	Total	18730	6462	34.5
Big & Little Chapman				
	Crooked Creek			
	Levi Tenney			
	William Gillion			
	Shroyer			
	Total	3242	744	22.9
Pike				
	Deeds	21730	7676	35.3
	Beyer	1675	168	10.0
	Total	23405	7844	33.5
Ridinger				
	Shanton	4900	1426	29.1
	Whitley Co.	13426		
Big Barbee				
	Grassy Creek	10974	3870	35.3
	Total	24400		
Little Barbee				
	Stonebruner-Putney	2641	714	27.0
	Total			
Irish				
	Little Barbee			
Sechrist				
Sawmill				
	Irish			
	Sechrist			
Tippecanoe				
	Hanna B. Walker	574	189	32.9
	Total			

Table 1

Watershed Acreage and Percent Highly Erodible Land

Lake	Ditch	Drainage Acreage	H.E.L.	% HEL
Backwaters				
	Tippecanoe River			
Webster				
	Total	17000		
James				
	Tippecanoe River			
	Kuhn (600N)	1638	258	15.8
Wawasee				
	Turkey Creek			
	Dillion Creek			
	Papakeechie			
Syracuse				
	Wawasee			
Beaver Dam				
	Eaton	800	201	25.1
Diamond				
	Michaels			
	Southeast			
Yellow Creek				
	Yellow Creek			
	Outflow of Diamond			
	Total	6042	1045	17.3
Dewart				
	Westlake Fetters	2100	792	37.7
Hoffman				
	Wolf Arm 700W			
	Easterday			
	Total	4500	103	2.3
Silver				
	Funk	1467	77	5.2
	N. edge Town			
	W. of 14&15			
Hill				
Carr				
	200W			
Center				
	Storm Drains			
Sellers				
Serburn				

Table 1 (cont.)

Lake Size, Trophic Class, and Total Phorphorus

Lake	Size (Acres)	Trophic Class	Total Phosphorus mg/l 1975	1983	1988
Beaver Dam	146	3	0.85		0.16
Diamond					0.23
Hill	66	2	0.12		
Yellow Creek	151	3	0.09		0.12
Ridinger	136	2	0.05		0.55
Kuhn	137	2	0.01	0.07	0.14
Big Barbee	304	2	0.05	0.09	0.14
Little Barbee	74	3	0.08	0.08	0.12
Irish	182	2	0.05	0.07	0.09
Sechrist	105	1	0.02	0.07	0.14
Sawmill	36	2	0.01	0.07	0.12
Backwaters					0.19
Webster	774	2	0.06		0.07
James	282	2	0.04		0.06
Tippecanoe	768	1	0.05	1982 0.04	0.04
Oswego	41	2	0.04		0.06
Wawasee	3060	1	0.04		0.01
Syracuse	414	1	0.01		0.06
Dewart	551	2	0.03		0.06
Palestine	232	3	0.91		0.31
Silver	102	3	0.34		
Carr	79	3	0.14		

Table 2

Lake Size, Trophic Class, and Total Phorphorus

Lake	Size (Acres)	Trophic Class	Total Phosphorus mg/l 1975	1983	1988
Big Chapman	581	1	0.01		0.07
Little Chapman	177	2	0.03		0.06
Pike	203	2	0.09	0.12	0.27
Little Pike	25	2	0.09		0.14
Center	120	2	0.04		0.06
Winona	562	2	0.13	1985 0.03	0.03
Hoffman	180	2	0.05		0.07
Sellers					1.15
Serburn					0.25

Table 2 (cont.)

LaKe Secchi Disk, Eutrophication Index, and Number of Homes

Lake	Secchi Disk 1975	1983	1988	Eutrophic Index	Homes 1980
Beaver Dam	4		2	55	173
Diamond			2.5		54
Hill	12			31	
Yellow Creek	2.5		4	67	170
Ridinger	3.5		4	58	116
Kuhn	9.8	9.5	10	15	114
Big Barbee	5	5.5	5	38	207
Little Barbee	5	4.5	5	56	154
Irish	7	6.5	5	45	129
Sechrist	9	16	7	24	210
Sawmill	5.5	5.5	5	33	80
Backwaters					110
Webster	3		5.7	37	516
James	6.5		3	39	104
Tippecanoe	7		6	12	571
Oswego	5.5		6	33	113
Wawasee	7.5		8	16	1323
Syracuse	13		8	4	228
Dewart	5.5		7	36	395
Palestine	0.5		1.7	55	215
Silver	2.8			51	205
Carr	3.5			50	3

Table 3

LaKe Secchi Disk, Eutrophication Index, and Number of Homes

Lake	Secchi Disk 1975	1985	1988	Eutrophic Index	Homes 1980
Big Chapman	10		9	18	346
Little Chapman	7		9	25	108
Pike	3	3	3	45	166
Little Pike	0.5		2.5	31	
Center	4.5		5	31	10
Winona	3.5		6.5	40	243
Hoffman	7		4	23	
Sellers			2		
Serburn			3		

Table 3 (cont.)

Phosphorus Levels of Inflows

Lake	Ditch	Total Phosphorus mg/l 1988 June	1988 July	1988 Aug.	1985
Palestine					
	Williamson	9.2	0.42	0.22	
	Slone-Adams	0.73	0.64		
	Cauffman	0.6	0.82		
	Magee	1.15	0.48		
	Total				
Winona					
	Peterson		0.14		
	Keefer-Evans		0.14		0.04
	Wyland		0.14		0.05
	Total				
Big & Little Chapman					
	Crooked Creek		0.71		
	Levi Tenney				
	William Gillion				
	Shroyer				
	Total				
Pike					
	Deeds		0.09		
	Beyer				
	Total				
Ridinger					
	Shanton		0.26		
	Whitley Co.				

Big Barbee											
	Grassy Creek	0.19	1983 0.04	1983 0.12	1984 0.03	1985 0.09	1985 0.05	1986 0.01	1987 0.06	1988 0.19
	Total									
Little Barbee										
	Stonebruner-Putney	0.15				0.23	0.05	0.04		
	Total	0.12								
Irish										
	Little Barbee									
Sechrist										
Sawmill										
	Irish									
	Sechrist									

Tippecanoe								
	Grassy Creek	1982 0.13	1983 0.04	1984 0.06		1985 0.04	1986 0.02	1987 0.01
	Hanna B. Walker							
	Total							

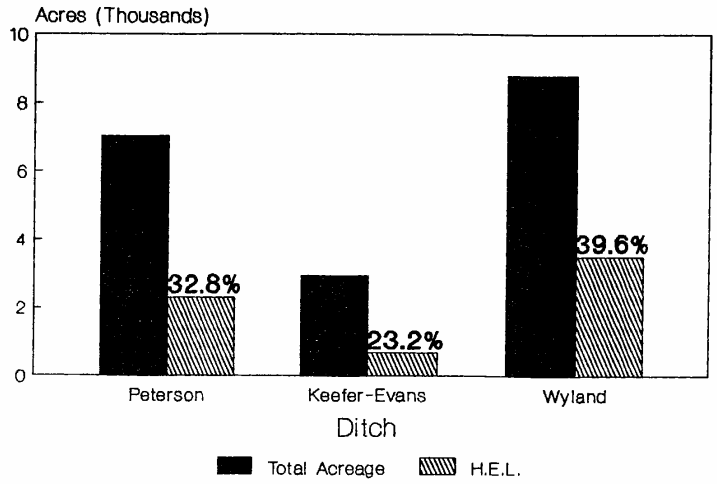
Table 4

Phosphorus Levels of Inflows

Lake	Ditch	Total Phosphorus mg/l 1988	1988	1988	1985
Backwaters					
	Tippecanoe River		0.24		
Webster					
	Total		0.18		
James					1982
	Tippecanoe	0.07	0.11		0.1
	Kuhn (600N)		0.11		
Wawasee					
	Turkey Creek		0.04		
	Dillion Creek		0.09		
	Papakeechie		0.01		
Syracuse					
	Wawasee		0.16		
Beaver Dam					
	Eaton		0.24		
Diamond					
	Michaels		0.28	0.2	
	Southeast		0.01		
Yellow Creek					
	Yellow Creek		0.15		
	Outflow of Diamond		0.19	0.13	
	Total				
Dewart					
	Westlake Fetters		0.07		
Hoffman					
	Wolf Arm 700W		0.09		
	Easterday		0.02		
	Total				
Silver					
	Funk		0.19		
	N. edge Town		1.9		
	W. of 14&15		2.7		
Hill					
Carr					
	200W				
Center					
	Storm Drains				
Sellers					
Serburn					

Table 4 (cont.)

Winona Lake Watershed
Highly Erodible Land



Palestine Lake Watershed
Highly Erodible Land

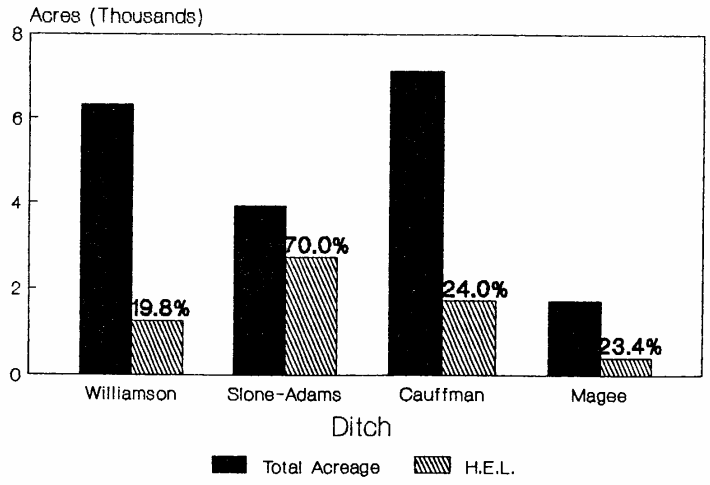
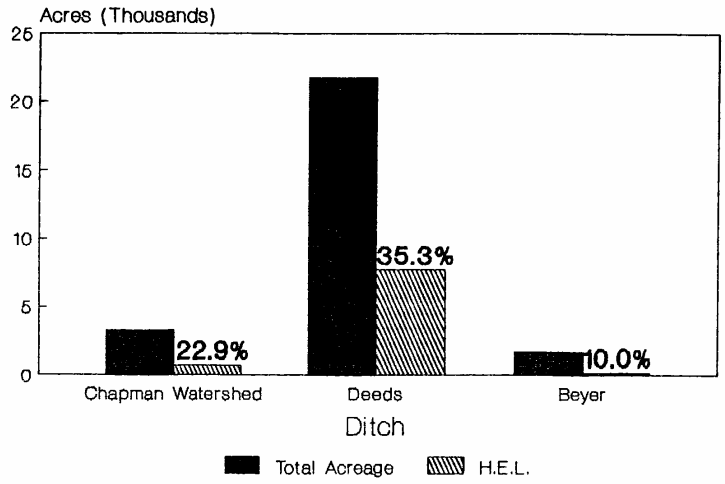
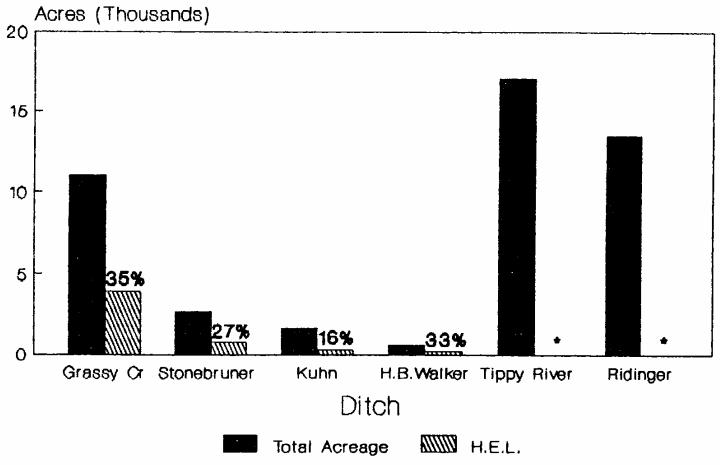


Figure 1

Pike Lake Watershed
Highly Erodible Land



Tippecanoe Lake Watershed
Highly Erodible Land



* undetermined

Figure 1 (cont.)

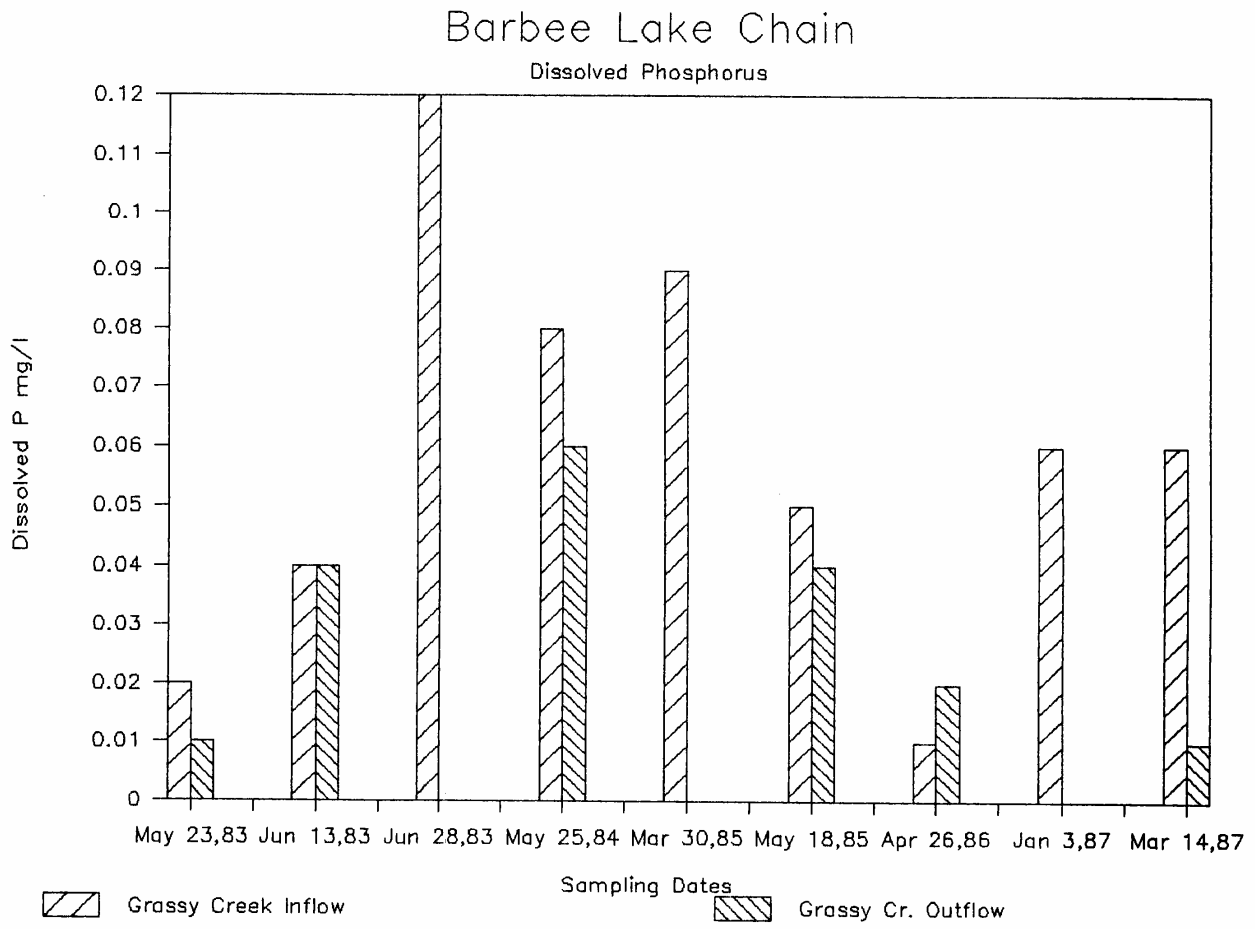

Barbee Lake Chain
Dissolved Phosphorus
Dissolved P mg/l
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
May 23,83
Jun 13,83
Jun 28,83
May 25,84
Mar 30,85
May 18,85
Apr 26,86
Jan 3,87
Mar 14,87
Sampling Dates
Grassy Creek Inflow
Grassy Cr. Outflow

Figure 2

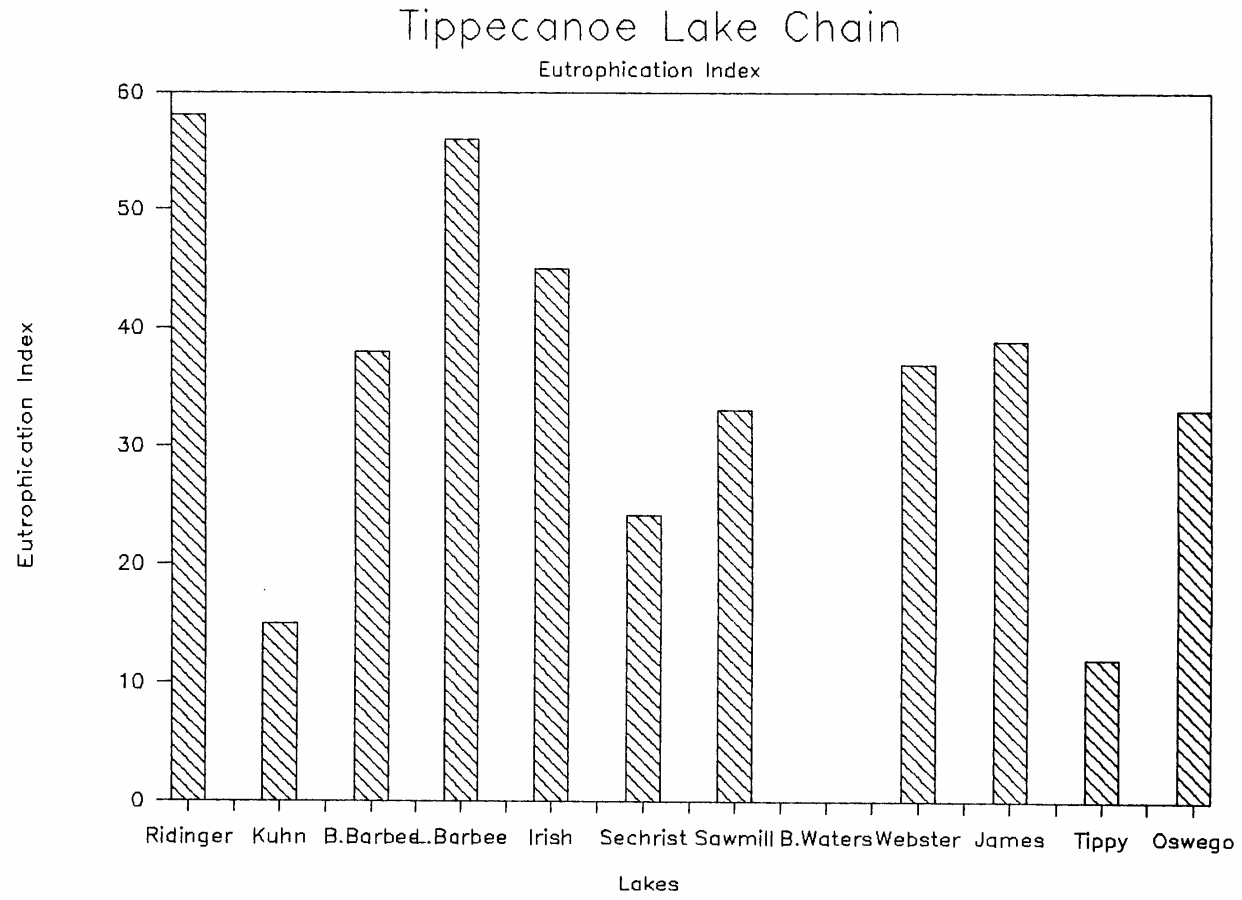
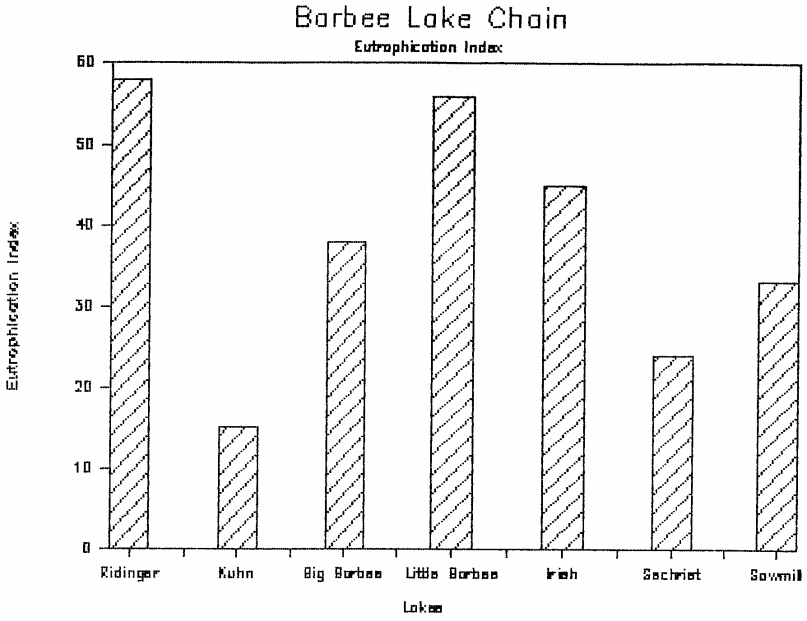

Tippecanoe Lake Chain
Eutrophication Index
60
50
40
30
20
10
0
Eutrophication Index
Ridinger
Kuhn
B.Barbee
L.Barbee
Irish
Sechrist
Sawmill
B.Waters
Webster
James
Tippy
Oswego
Lakes

Figure 3


Barbee Lake Chain
Eutrophication Index
Eutrophication Index
60
50
40
30
20
10
0
Ridinger
Kuhn
Big Barbee
Little Barbee
Irish
Sechrist
Sawmill
Lakes

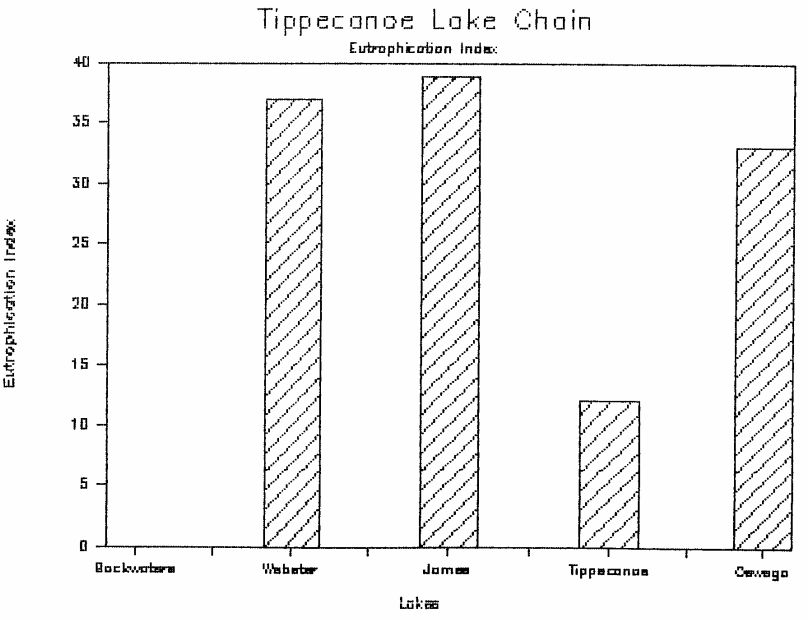
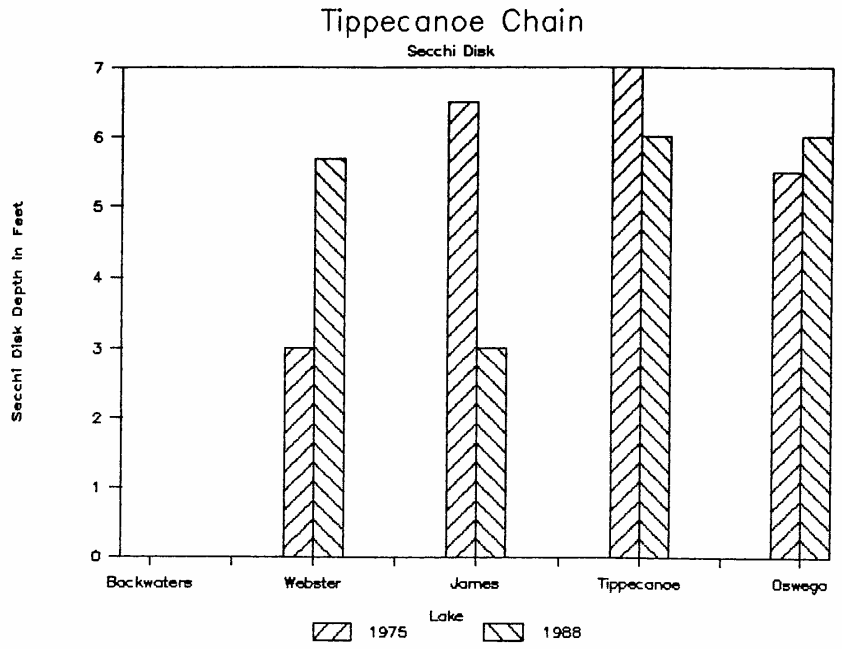

Tippecanoe Lake Chain
Eutrophication Index
Eutrophication Index
40
35
30
25
20
15
10
5
0
Backwaters
Webster
James
Tippecanoe
Oswego
Lakes

Figure 4


Tippecanoe Chain
Secchi Disk
Secchi Disk Depth in Feet
7
6
5
4
3
2
1
0
Backwaters
Webster
James
Tippecanoe
Oswego
Lake
1975
1988

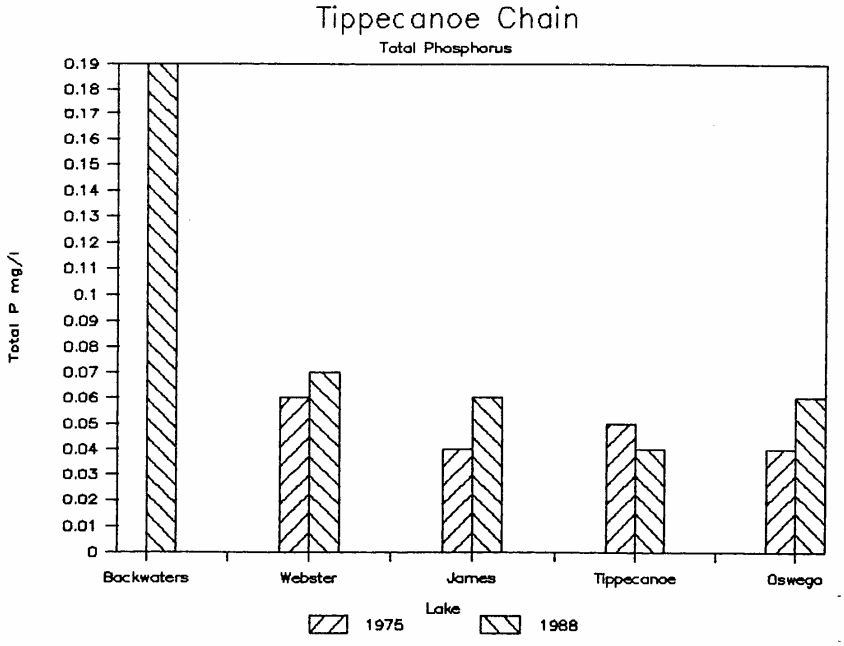
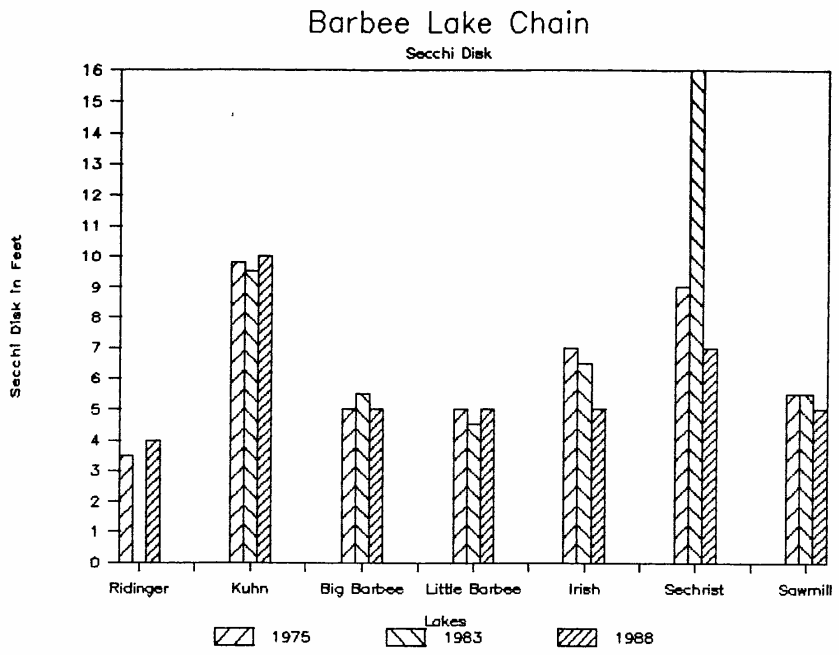

Tippecanoe Chain
Total Phosphorus
Total P mg/l
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Backwaters
Webster
James
Tippecanoe
Oswego
Lake
1975
1988

Figure 5


Barbee Lake Chain
Secchi Disk
Secchi Disk In Feet
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Ridinger
Kuhn
Big Barbee
Little Barbee
Irish
Sechrist
Sawmill
Lakes
1975
1983
1988

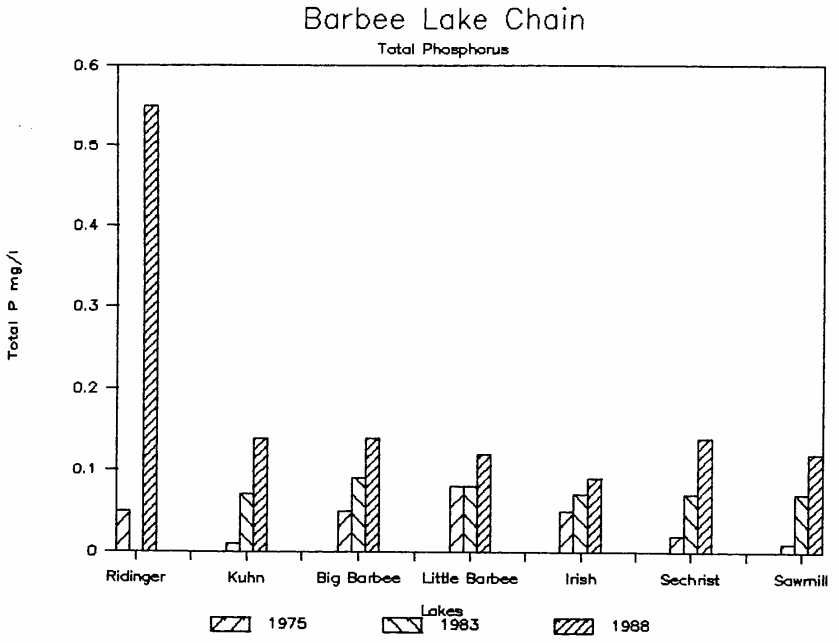
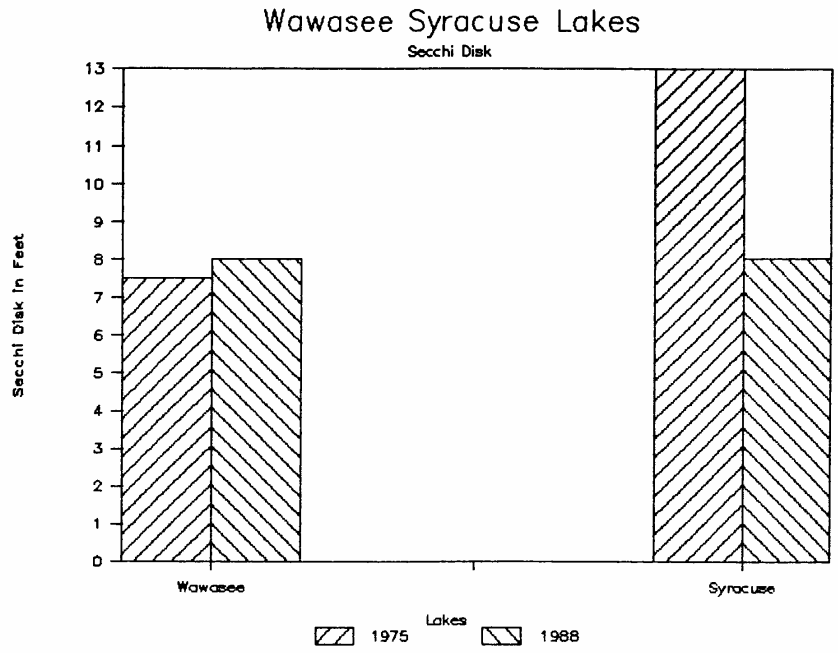

Barbee Lake Chain
Total Phosphorus
Total P mg/l
0.6
0.5
0.4
0.3
0.2
0.1
0
Ridinger
Kuhn
Big Barbee
Little Barbee
Irish
Sechrist
Sawmill
Lakes
1975
1983
1988

Figure 6


Wawasee Syracuse Lakes
Secchi Disk
Secchi Disk In Feet
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Wawasee
Syracuse
Lakes
1975
1988

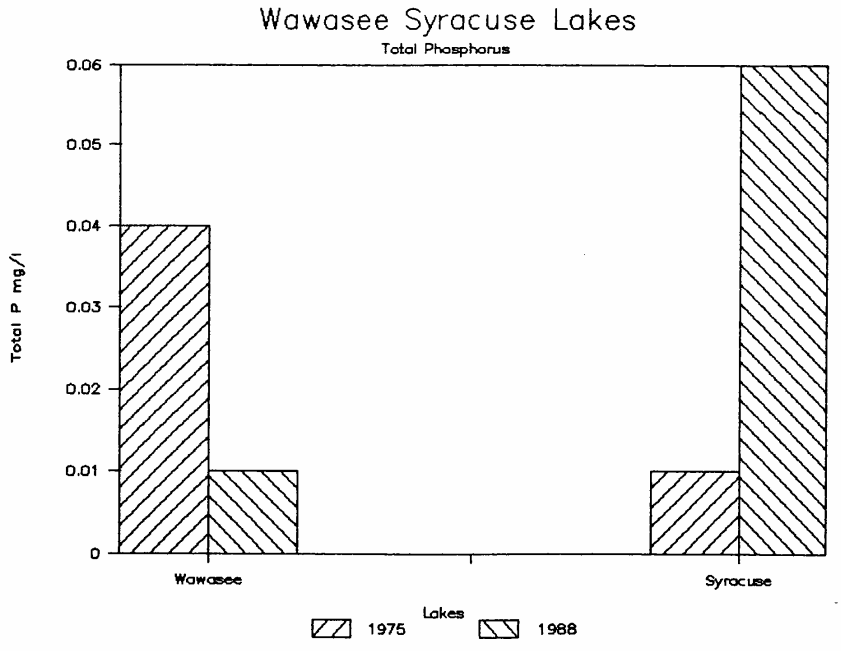
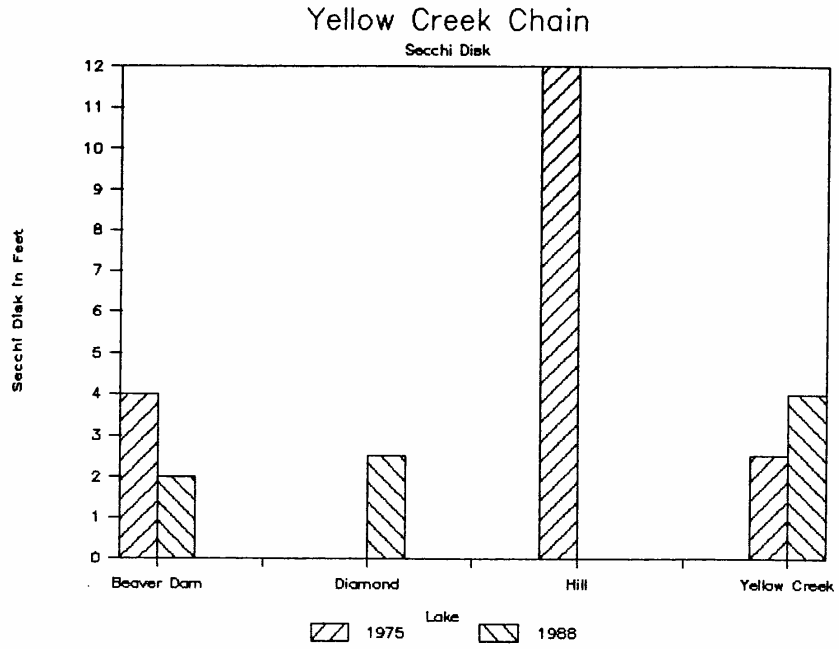

Wawasee Syracuse Lakes
Total Phosphorus
Total P mg/l
0.06
0.05
0.04
0.03
0.02
0.01
0
Wawasee
Syracuse
Lakes
1975
1988

Figure 7


Yellow Creek Chain
Secchi Disk
Secchi Disk In Feet
12
11
10
9
8
7
6
5
4
3
2
1
0
Beaver Dam
Diamond
Hill
Yellow Creek
Lake
1975
1988

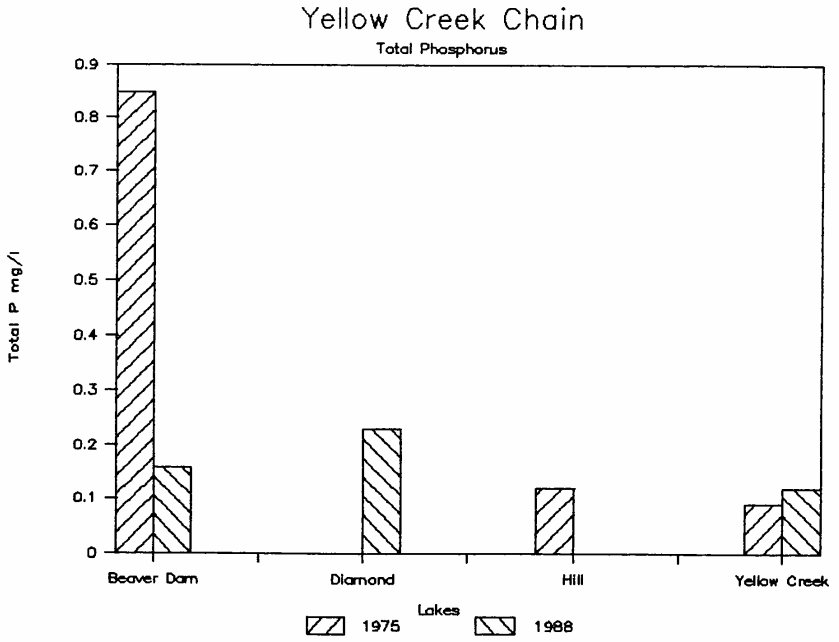
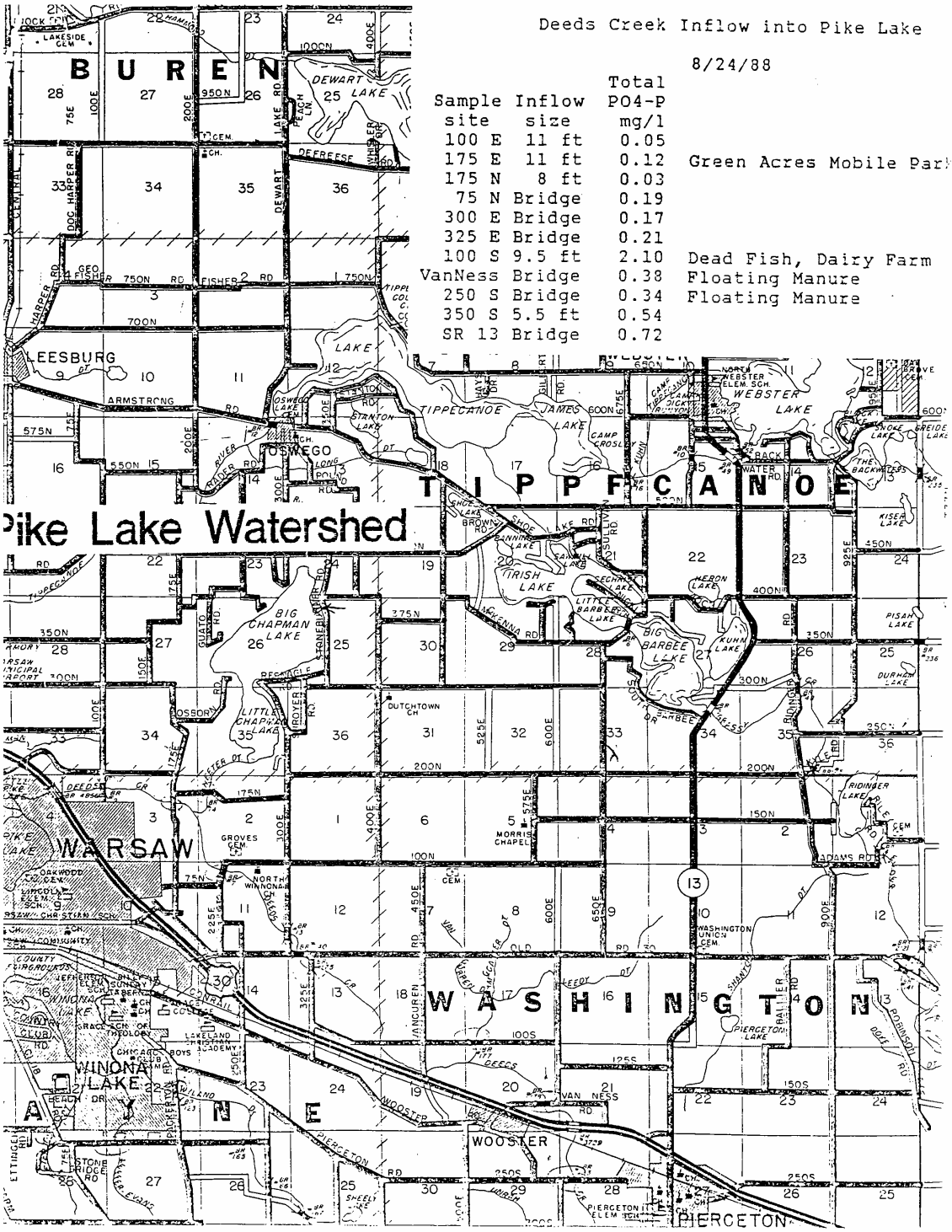

Yellow Creek Chain
Total Phosphorus
Total P mg/l
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Beaver Dam
Diamond
Hill
Yellow Creek
Lakes
1975
1988

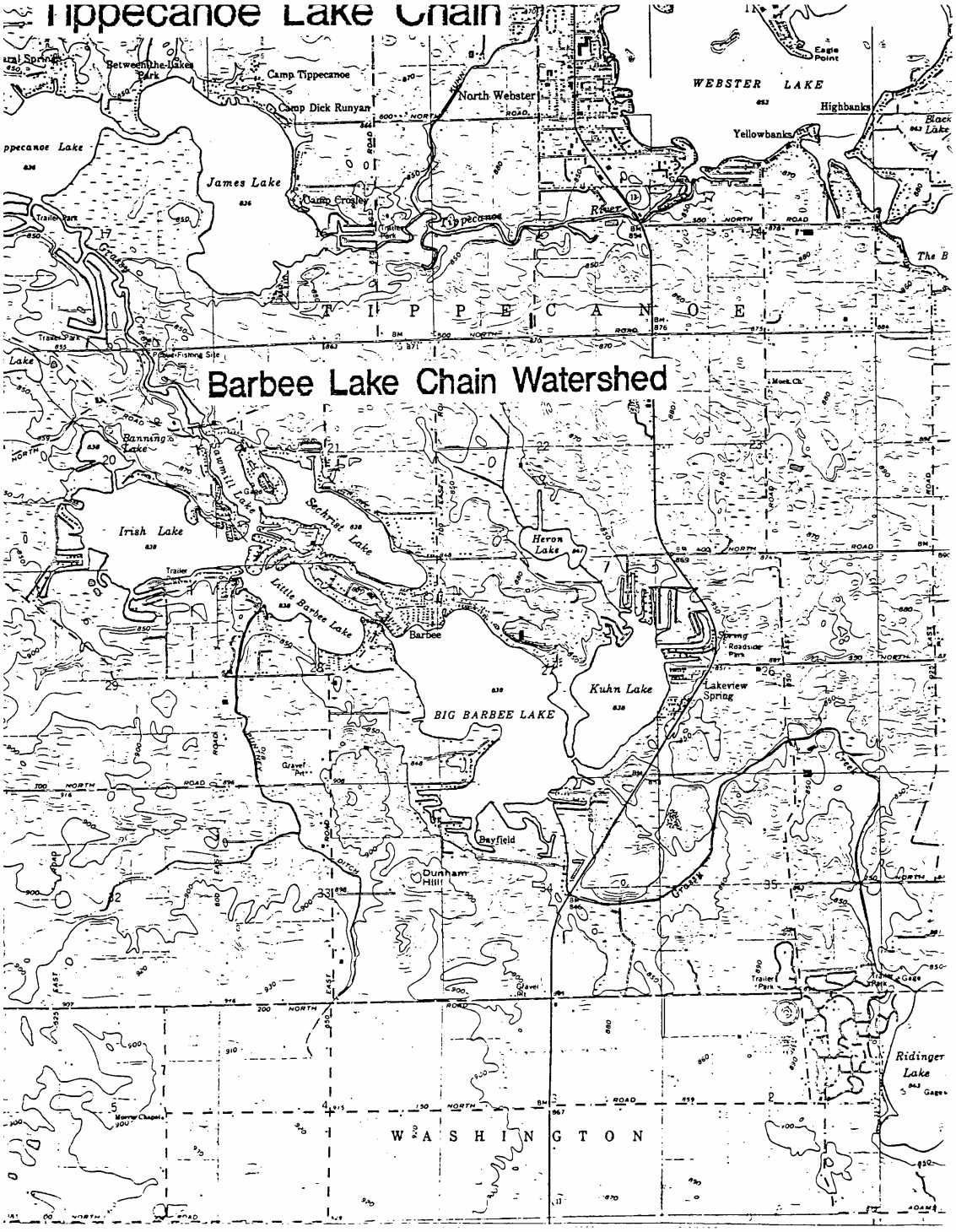
Figure 8

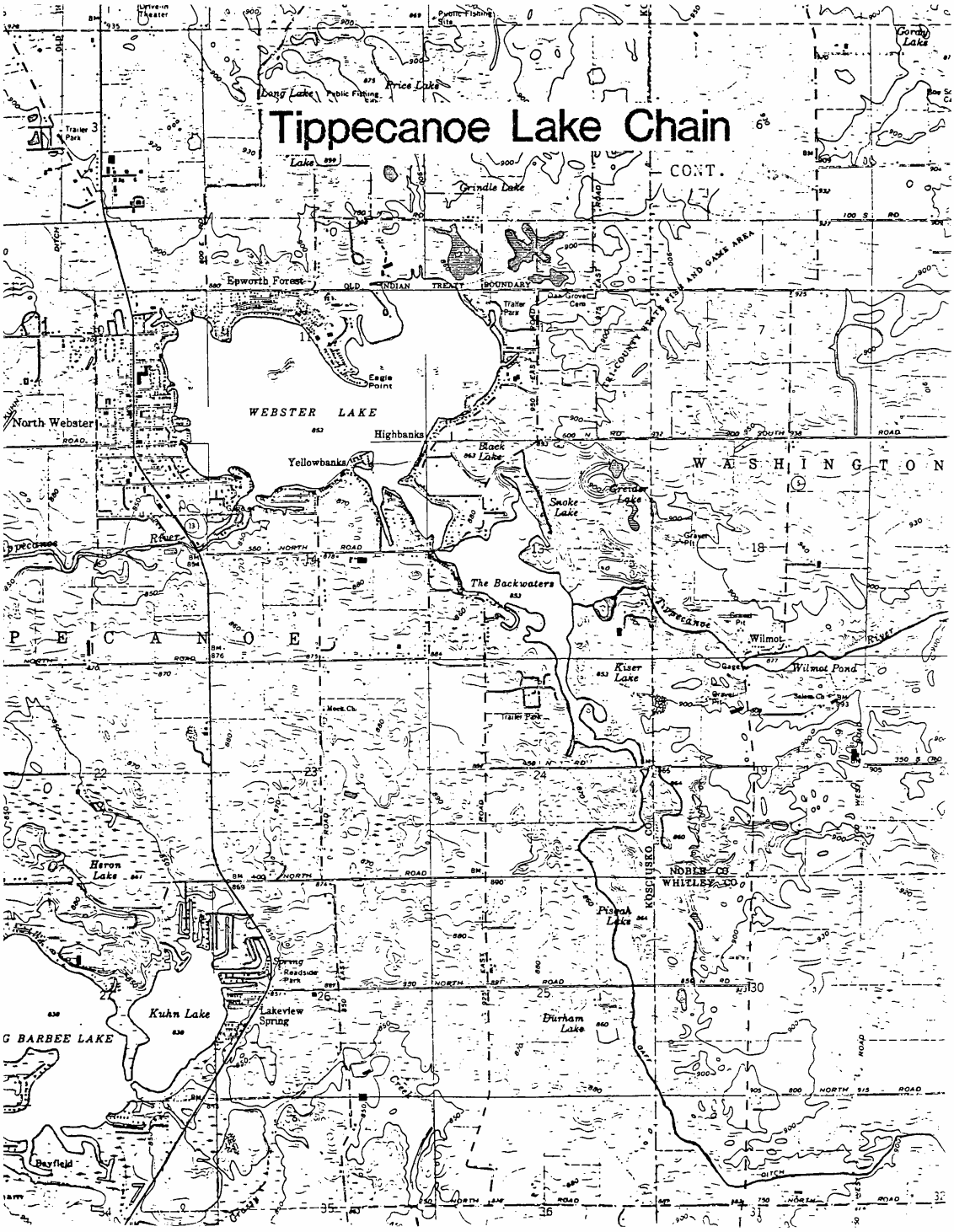


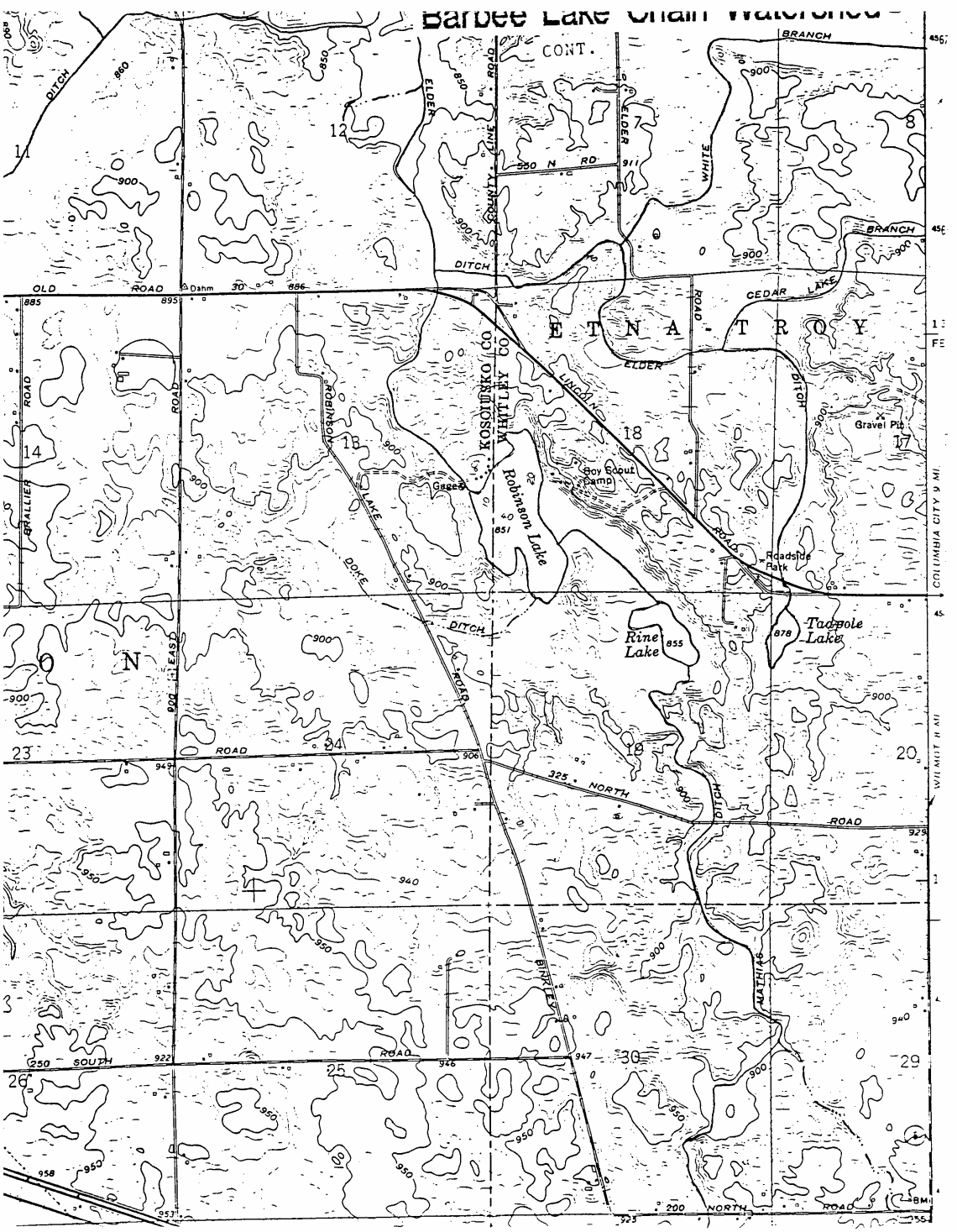
Deeds Creek Inflow into Pike Lake

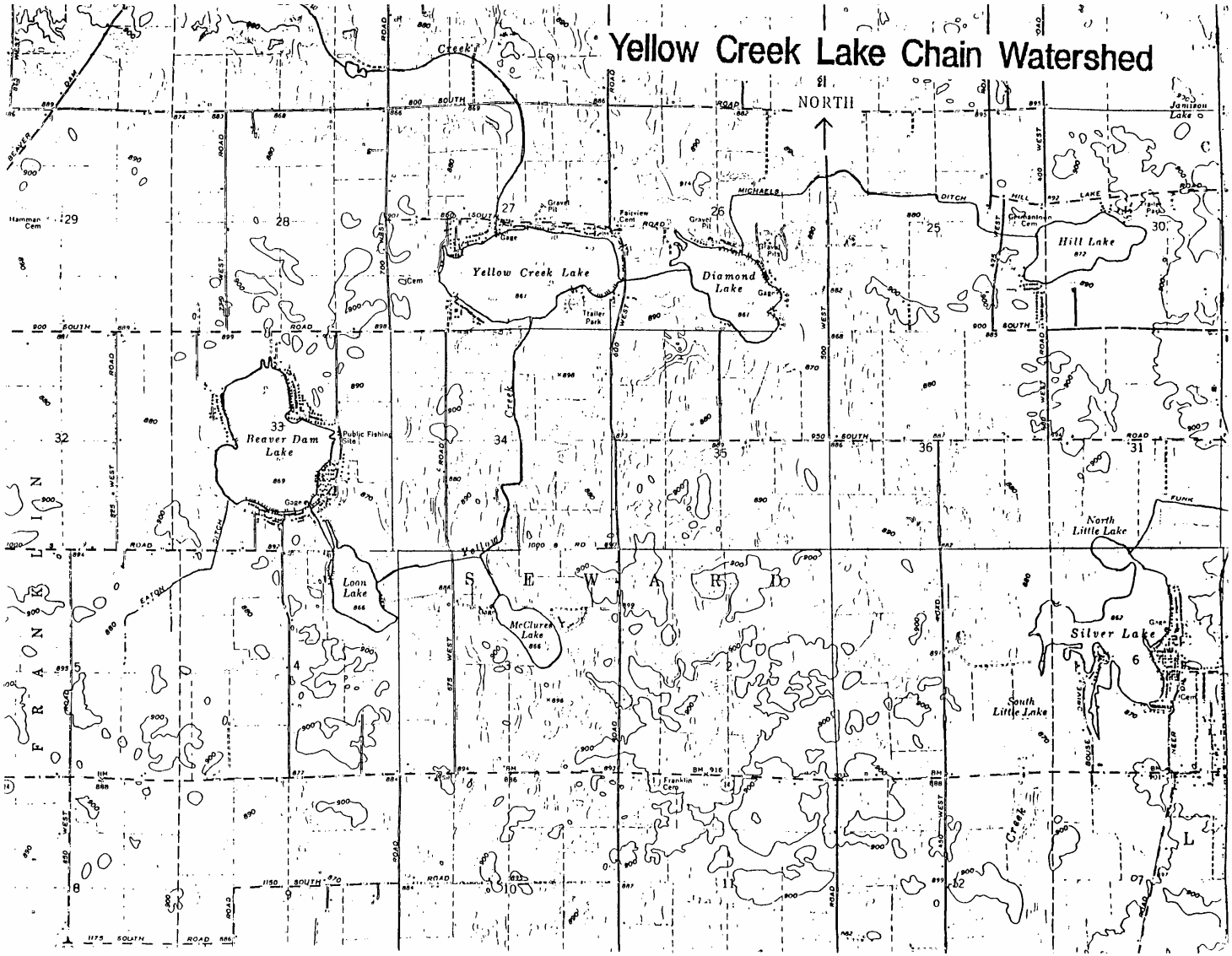
8/24/88

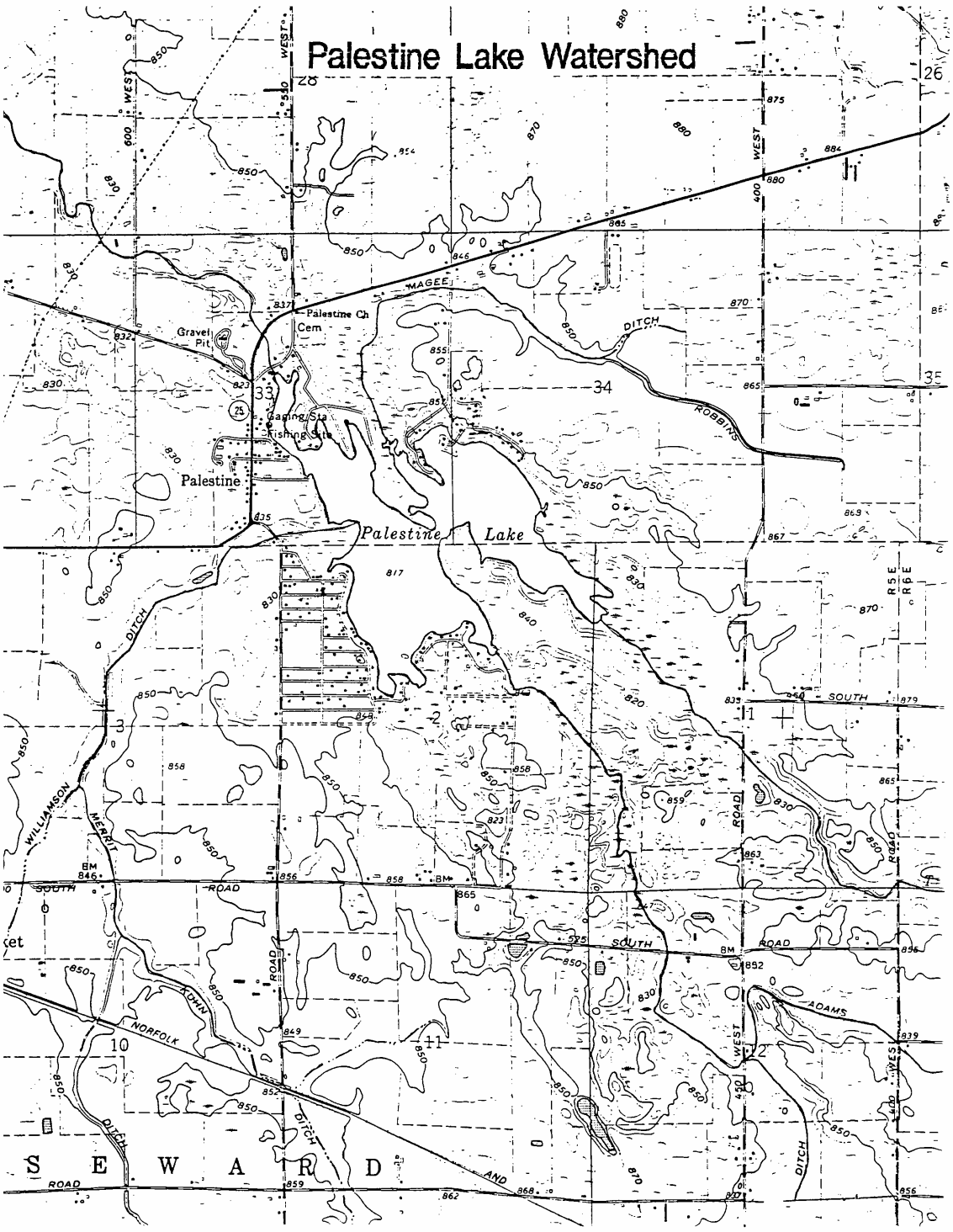
Sample site	Inflow size	Total PO4-P mg/l	
100 E	11 ft	0.05	
175 E	11 ft	0.12	Green Acres Mobile Par
175 N	8 ft	0.03	
75 N	Bridge	0.19	
300 E	Bridge	0.17	
325 E	Bridge	0.21	
100 S	9.5 ft	2.10	Dead Fish, Dairy Farm
VanNess	Bridge	0.38	Floating Manure
250 S	Bridge	0.34	Floating Manure
350 S	5.5 ft	0.54	
SR 13	Bridge	0.72	

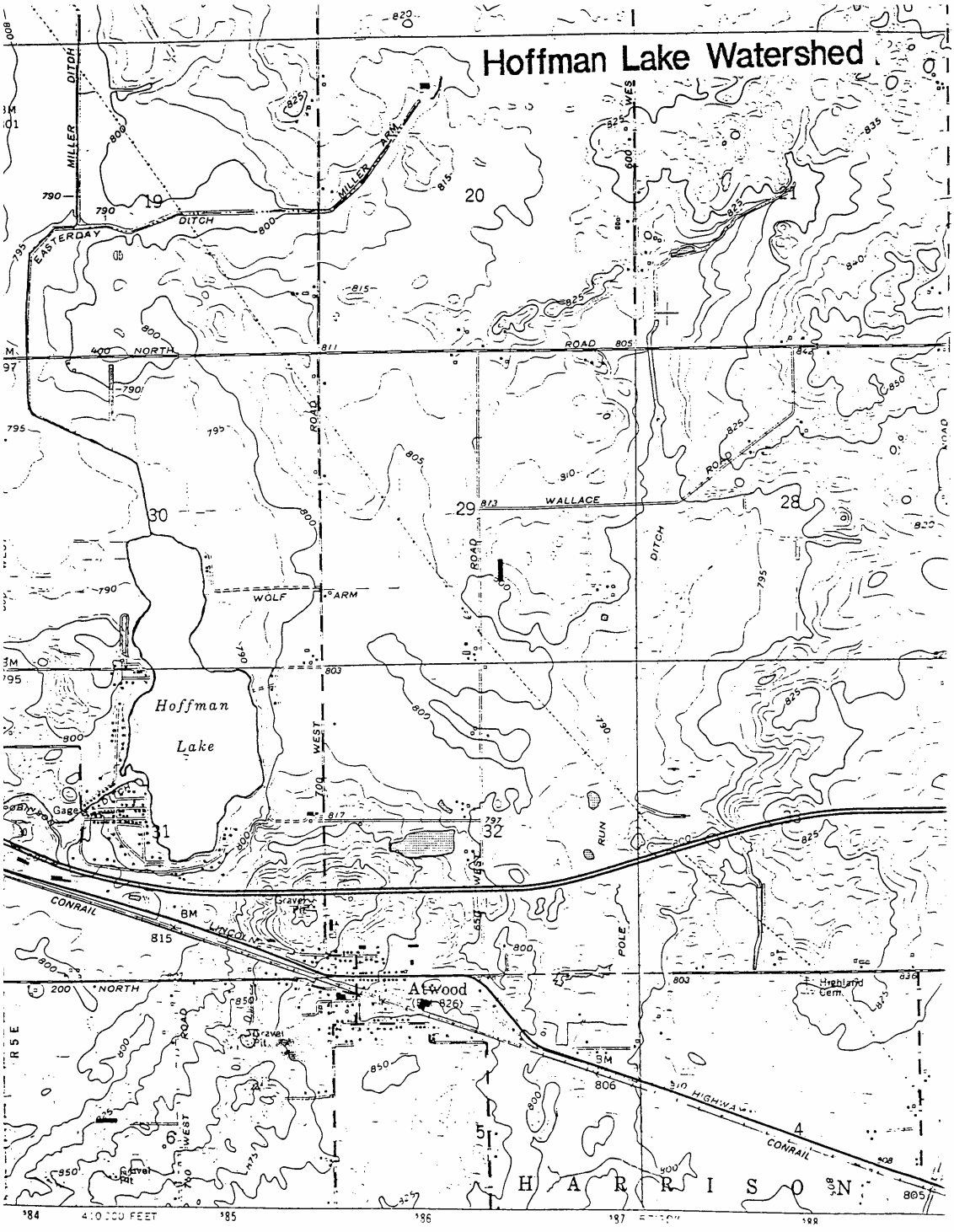

Tippecanoe Lake Chain
Barbee Lake Chain Watershed
Between the Lakes Park
Camp Tippecanoe
Camp Dick Runyan
North Webster
WEBSTER LAKE
Eagle Point
Highbanks
Yellowbanks
Black Lake
James Lake
Camp Crosley
Tippecanoe River
Trailer Park
Public Fishing Site
TIPPECANOE
Banning Lake
Sawmill Lake
Sechrist Lake
Irish Lake
Heron Lake
Little Barbee Lake
Barbee
Kuhn Lake
BIG BARBEE LAKE
Lakeview Spring
Bayfield
Dunham Hill
Ridinger Lake
WASHINGTON

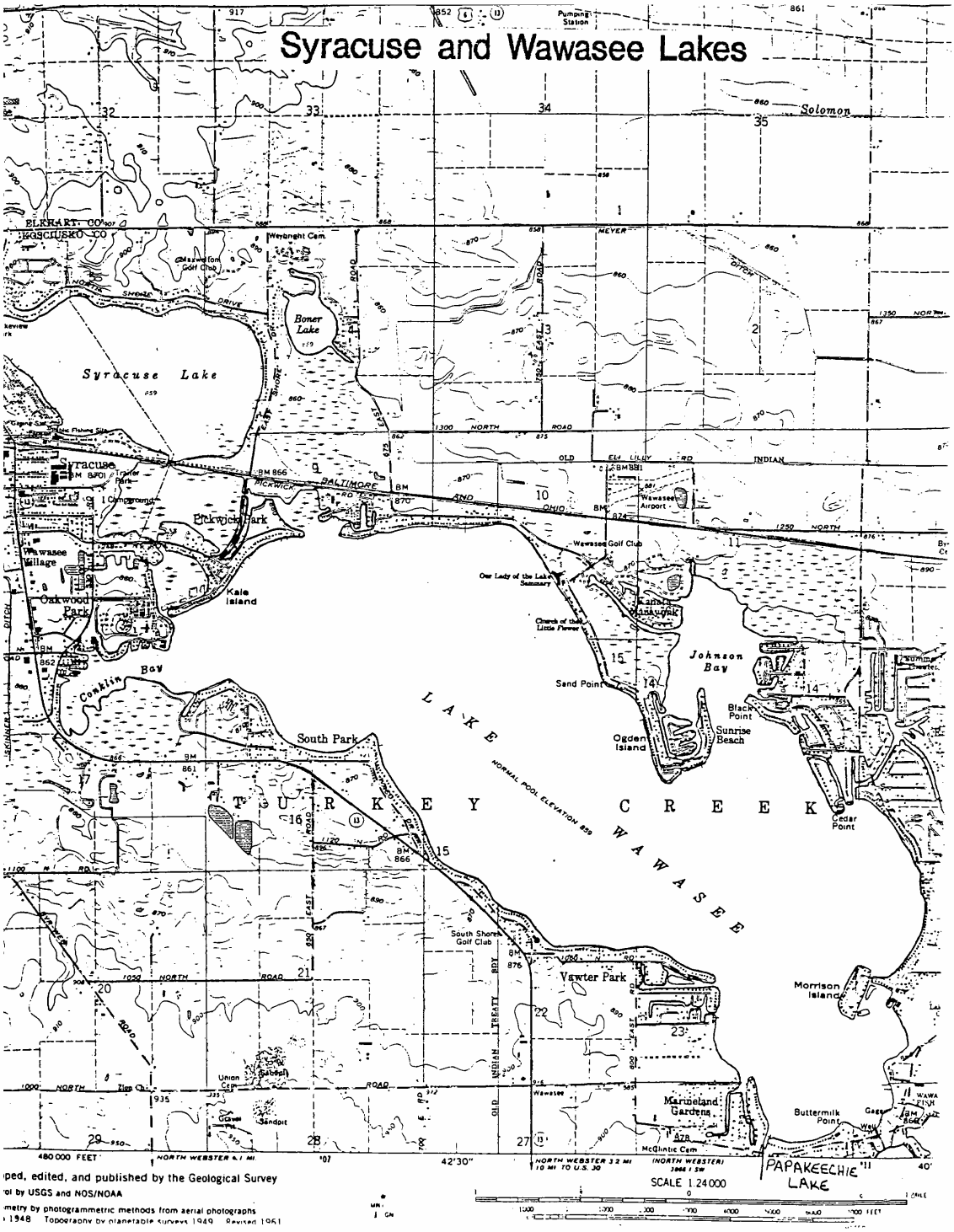

Tippecanoe Lake Chain
WEBSTER LAKE
North Webster
Epworth Forest
Eagle Point
Highbanks
Yellowbanks
Black Lake
Grindle Lake
Snake Lake
The Backwaters
Kiser Lake
Wilmot
Wilmot Pond
Tippecanoe River
Heron Lake
Kuhn Lake
Lakeview Spring
Spring
Readside Park
BARBEE LAKE
Bayfield
Pisgah Lake
Durham Lake
Oswald Lake
Price Lake
Long Lake
Public Fishing Site
Trailer Park
Drive-in Theater
Oak Grove Cem.
OLD INDIAN TREATY BOUNDARY
KOSCIUSKO CO.
NOBLE CO.
WHITLEY CO.
CONT.
WASHINGTON
PECANOE
NORTH ROAD
SOUTH ROAD
EAST ROAD
WEST ROAD


Barbee Lake Chain Watershed
CONT.
BRANCH
DITCH
ELDER
COUNTY LINE ROAD
350 N RD
WHITE
OLD ROAD
CEDAR LAKE ROAD
ETNA TROY
KOSCIUSKO CO.
WHITLEY CO.
LINDA LN
MORNIBOR
GREEN
Robinson Lake
Boy Scout Camp
Gravel Pit
Roadside Park
DOKE LAKE
Rine Lake
Tadpole Lake
ROAD
325 NORTH
250 SOUTH
200 NORTH
BINKLEY
MATHIAS
GRALLIER
COLUMBIA CITY 9 MI.
WILMOT 11 MI.


Yellow Creek Lake Chain Watershed
NORTH
Yellow Creek Lake
Diamond Lake
Hill Lake
Beaver Dam Lake
Loon Lake
McClures Lake
North Little Lake
Silver Lake
South Little Lake
FRANKLIN
SEWARD


Palestine Lake Watershed
Palestine Ch
Cem
Gravel
Pit
Gaging Sta
Fishing Site
Palestine
Palestine Lake
MAGEE
DITCH
ROBBINS
WILLIAMSON
MERRIT
SOUTH
ROAD
NORFOLK
SOUTHERN
ADAMS
WEST
R5E
R6E
S E W A R D
AND


Hoffman Lake Watershed
MILLER DITCH
MILLER ARM
EASTERLY DITCH
NORTH ROAD
WALLACE ROAD
WOLF ARM
Hoffman Lake
WEST ROAD
DITCH
RUN
POLE
CONRAIL
LINCOLN
Gravel Pit
Atwood
Highland Cem.
HIGHWAY
HARRISON
19
20
21
28
29
30
31
32
5
6
4
R5E



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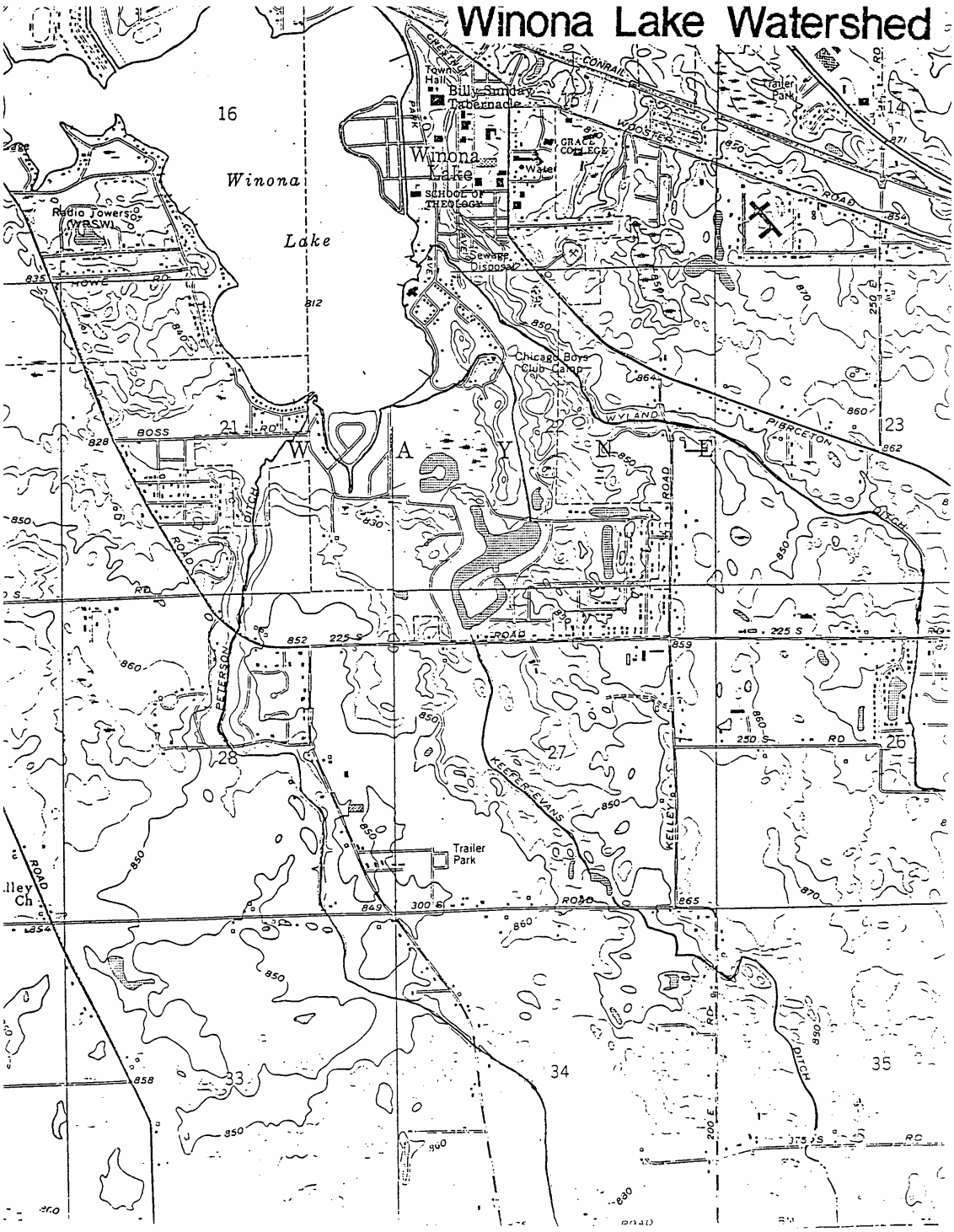
Winona Lake Watershed
Winona
Lake
Town Hall
Billy Sunday Tabernacle
Trailer Park
GRACE COLLEGE
Winona Lake SCHOOL OF THEOLOGY
Water
Sewage Disposal
Radio Towers (WRSW)
Chicago Boys Club Camp
CONRAIL
WOOSTER
ROAD
HOWE RD
BOSS ROAD
WYLAND ROAD
PIERCEVIEW
PIERCETON
PETERSON ROAD
KELLEY ROAD
KEEGE-EVANS ROAD
DITCH
Trailer Park
16
15
14
21
22
23
28
27
26
33
34
35

Summary and Recommendations

Twenty eight different lakes and their respective watersheds were studied during the summer of 1988. The multiple lake chains which closely tie the water quality characteristics of individual lakes together are unique features of a large portion of the Kosciusko County lakes. This study concentrated on identifying activities in the watershed of each lake that is contributing to water quality problems within the lake. Since the Lake Enhancement program is part of the T by 2000 effort, sediment and nutrient contributors were the most completely analyzed.

With the summer of 1988 being one of driest in Indiana history, it placed some limits on the type of data that could be collected, especially the inflow rates of the streams and ditches. But this had very little effect on total evaluation of factors causing water quality problems for the lakes.

Several types of information was obtained to determine the magnitude of the problems being caused by activities in the various watersheds of the county.

It is obvious that agricultural activities make up the largest percent of the acreage in each watershed, but this does not mean that in every situation they are contributing the most sediments and nutrients to the lakes. The percentage of soil types and slopes that constitute highly erodible land (H.E.L.) was calculated from soil maps for each watershed. Also the status of the many animal feeding operations was determined. This information indicates the potential for water quality problems caused by agriculture. Efforts to maintain or implement best management practices need to be concentrated on these critical areas.

Development activity was found to be a major contributor of sediments and nutrients in a couple of the watersheds. The new golf course and associated residential development in the Wyland Ditch watershed flowing into Winona Lake and the commercial developments on the east edge of Warsaw within the Deeds Ditch watershed flowing into Pike Lake are two current obvious examples.

Sewage treatment plants both public and semi-public were not meeting their NPDES permit limits and, therefore, they are contributing significant levels of nutrients to some the lakes. The Pierceton STP is one such example with its high phosphate contribution to Deeds Ditch and ultimately Pike Lake. Also the town of Silver Lake is having a negative impact on Silver Lake with its high nutrient inputs. Five semi-public plants that supposedly treat sewage from mobile home parks were in violations of their permits, one for as long as seven years. Other small towns such as Burkett are discharging elevated levels of phosphate into the Williamson Ditch which flows into Palestine Lake. All indications are that many septic tanks are draining into the ditch rather than into leach fields.

There needs to be better ditch design on some ditches because some of the sediment and associated phosphates are

coming from in stream erosion caused by steep side slopes and poor bank stabilization due to a lack of vegetation. Buffer strips of grass need to established in some critical areas to reduce the impact of farming and development activities along the banks of some ditches and streams.

The lake residential areas that have high ground water and porous soils need to consider alternative methods of sewage treatment, such as mounds or cluster systems. The current trend from seasonal to year around use of many lake homes is placing additional nutrient flow into the ground water and ultimately the lake in the above mentioned critical areas.

The overall T by 2000 Program is designed to help correct lake problems that can also be prevented from reoccurring by improved management within the watershed. This dual approach will reduce the rate of eutrophication or aging of the Kosciusko County lakes. It should be obvious from this study that many things can be done within the county without lake enhancement funds to improve the management of current and future watershed activities. This will have the same benefits of slowing down the eutrophication process as the proposed lake enhancement projects.

County government such as the Drainage Board, the Plan Commissions, town councils, the Health Department, and the Soil and Water Conservation District all need to consider the impact of their activities and decisions on one of the county's most important resources, the lakes.

State government, specifically the Indiana Department of Environmental Management, needs to be held more closely responsible for their regulatory activities of feed lot operations and sewage treatment plant compliance.

In addition to the need to improve the management techniques in the areas mentioned above, this preliminary study has identified the following specific watersheds that are most conducive to solutions within the framework of the Lake Enhancement Program.

Wyland Ditch on Winona Lake - The large sandbar at the mouth of the ditch on the south edge of the public beach should be removed. At the same time several practices could be implemented within the watershed to reduce the amount of sediment and nutrient inflow into Winona Lake. The EPA calculated that 46.8% of the annual total phosphorus loading and 49.5% of the total nitrogen loading of Winona Lake came from the Wyland Ditch. Wetland areas a short distance upstream from the lake could provide an opportunity for improved water quality if they were included in the flow pattern of the Wyland Ditch.

Stonebruner-Putney Ditch on Little Barbee - The sandbar in the lake and sediment from the filled channel should be removed. Erosion control practices and possible wetland construction would prove very beneficial to this watershed. This improvement would also reduce the nutrient input to several lakes in the Barbee and Tippecanoe chains in addition

to Little Barbee.

Pike and Little Pike Lakes and their large watershed of Deeds Creek - There are several factors contributing to the water quality problems of Pike and Little Pike Lakes. There are large nutrient inputs from Pierceton's Sewage Treatment Plant, and animal waste as shown on the Pike Lake Watershed map. The commercial development on the east side of Warsaw is creating increased runoff of poor quality. Some of this development is infringing on wetlands that had buffered Pike from storm surges that carry sediments and nutrients. The 21,730 acre watershed of Deeds Creek with its 35.3% highly erodible soil, Figure 1, can also contribute significant levels of sediments and nutrient to Pike and Little Pike Lakes if not properly managed.

Ridinger Lake and its watershed of the Shanton and Elder Ditches - Ridinger Lake had the highest phosphate level of the Barbee Lake Chain. This high value of 0.55 mg/l total phosphorus, Figure 6, could be due to large inputs from the Shanton and Elder Ditches or from internal loading. In either case, these nutrients could easily be transported down stream to the Barbee Lakes and ultimately Tippecanoe Lake. Therefore, the improved management of this watershed would also assure good water quality to the many lakes downstream as well as benefiting Ridinger Lake.

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